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FAQ

TOC/TN_b-Analyzer

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1 General Questions

1.1 Which applications are the TOC systems from Analytik Jena suitable for?

The TOC systems from Analytik Jena can be used for all known TOC applications, i.e. for TOC in aqueous samples or optionally also in solid samples (soils and waste).

Typical applications for TOC determination include: drinking water, ground water, surface water and wastewater (municipal and industrial), as well as pharmaceutical ultra-pure water applications (also cleaning validation), water in power stations or process water in semiconductor industries.

1.2 Which instrument is recommended for which application?

multi N/C® 2100/2100S: predominantly wastewater (also with high particle or salt content), typical concentration: < 1000 mg/l

multi N/C® 3100: almost all applications: power station water, typical concentration: < 1 mg/l; drinking water, typical concentration: < 5 mg/l; sea water, typical concentration: < 10 mg/l ground water and surface water, typical concentration: < 20 mg/l, waste water and eluates (also with high particle or salt content), typical concentration: < 1000 mg/l

multi N/C® UV HS: particle free water samples like: drinking water, typical concentration: < 5 mg/l, ground water and surface water, typical concentration: < 20 mg/l, DOC determination in waste water and eluates, typical concentration: < 1000 mg/l, acids, electrolytic bath, sea water (diluted)

multi N/C® pharma HT/UV: TOC in purified water (AP), water for injection purposes (WFI), cleaning validation (final rinse, eluted swabs), typical concentration: < 0.5 mg/l TOC, with additional swab module: cleaning validation following swab combustion

1.3 Which TOC instruments from Analytik Jena are recommended for unusual applications?

- TOC in hydrogen peroxide (recommended with multi N/C® 2100/2100S)
- TOC in concentrated acids (recommended with multi N/C® UV HS),
- TOC in galvanic baths (extremely high salinity), (recommended with multi N/C® UV HS)
- TOC in soil extract solutions (very high K_2SO_4 or $MgSO_4$ content), (recommended with multi N/C® 2100/2100S or multi N/C® 3100)
- TOC in sea water (multi N/C® UV HS or multi N/C 3100)
- TOC in brine solution (high concentrated salt solutions) (multi N/C® 2100/2100S or multi N/C® 3100)
- TN in protein solutions (multi N/C® 2100S)

1.4 Are the systems also available as standalone versions?

The multi N/C® 2100S and multi N/C® 3100 systems can be operated with a stand alone option. In this case the instrument is operated via a tablet PC with an integrated touch screen.

1.5 What options exist for determining TOC?

The system offers 3 possibilities for determination of a TOC value:

1. The difference technique TOC = TC – TIC
2. The direct technique NPOC
3. The NPOC+ technique for water samples with a very high inorganic carbon content (TIC).

1.6 How works the TOC determination using the difference method?

To determine TOC using the difference method, 2 separate sample aliquots of the sample to be analyzed are each injected into the TIC reactor and subsequently in the TC reactor. From the two results the difference is calculated and the corresponding TOC concentration is obtained.

1.7 How works the TOC determination using the NPOC method?

For TOC determination using the NPOC method, the sample is automatically or manually acidified to pH 2, the inorganic compounds are purged automatically according the time predefined by the user. Subsequently the injected into the TC reactor is done and as a direct result the amount of non purge able organic carbon is obtained (NPOC)

1.8 When is which method recommended?

NPOC is the method of choice for water samples with a higher TIC than TOC content, because the error for direct determination is much smaller than the one with indirect difference method. Typical applications are ultra-pure water analysis, ground and surface water, as well as drinking water. The difference method is partly preferred in waste water analysis in order to determine also eventually involved purgeable components of organic carbon (=POC).

1.9 Can POC be determined?

Yes, by using a POC module (basic or automatic) the parameter POC can be measured directly with multi N/C 3100.

A difference measurement POC = TOC – NPOC is possible with all multi N/C® systems. For this purpose TOC (by difference method) and NPOC (by direct method) have to be determined in one and the same sample.

1.10 How is the sample introduction working?

Sample introduction with multi N/C® 2100/ 2100S is done by direct injection. Here the sample is directly injected into a septum-free port with the aid of a micro liter syringe without tubing or valves (multi N/C® 2100 with septum port).

Advantage: ideal for samples, where a limited volume is available (e.g. pore water, protein solutions), especially suitable for particle containing samples.

For multi N/C® 3100, multi N/C® UV HS and multi N/C pharma® HT/UV, sample introduction is realized by the flow injection principle with the aid of a high resolution syringe pump and a single high quality distributor valve. This allows variable volumes to be dosed very precisely.

Advantage: larger injection volumes, parallel measuring and purging for double analysis speed in NPOC mode.

1.11 Which injection volumes are possible?

Model	Min. Inj. volume	Max. Inj. volume	Standard Inj. volume
multi NC® 2100/2100S	50 µl	500 µl	500µl
multi NC® 3100	100 µl	1000 µl	500µl
multi NC® UV HS / pharma UV	50 µl	20000 µl	5000 - 10000µl
multi NC® pharma HT	100 µl	3000 µl	2000µl

1.12 Which sample volumes are at least required?

For direct injection, only the volume is required that is also injected. For a triplicate determination a minimum of 500µl of sample are required.

For flow injection approx. 2.5 ml more sample than the actual injection volume is required. Reasonable sample volumina for a triplicate determination are ≥ 10 ml for multi N/C 3100.

Direct injection is therefore better suited for special applications for which only a limited sample quantity is available (e.g. pore water, protein analysis).

1.13 Which reagents are required for operation?

In thermocatalytic oxidation, phosphoric acid is used exclusively for determining inorganic carbon and hydrochloric acid for NPOC determination.

For wet chemical digestion using multi N/C® UV HS or multi N/C pharma® UV, the oxidation agent sodium peroxodisulfate is required alongside phosphoric acid for determining inorganic carbon. In contrast to thermal digestion, the samples are only acidified with sulfuric acid for NPOC determination with wet chemical digestion.

1.14 Is it permissible to acidify samples for NPOC determination in a high temperature instrument with sulfuric acid?

The preferred acid is hydrochloric acid. Other acids should not be used, if possible. In case H_2SO_4 can not be avoided, care must be taken that only as much acid is added as necessary to achieve a pH value of 2 (recommendation: 0.5 ml of 2 N H_2SO_4 to 100 ml of sample). For larger quantities of acid the use of an adsorber material (Sulfix) inside the combustion tube is recommended.

1.15 What purity grade is recommended for chemicals?

Chemicals used to prepare standard solutions and the acids should be of p.A purity grade.

1.16 What gas quality should be used?

Synthetic air (excluding CO_2 and hydrocarbons) or oxygen 4.5 (99.995%) is used to operate the thermocatalytic combustion systems. For the wet chemical UV systems nitrogen 5.0 (99.999%) or argon 5.0 (99.999%) is required.

1.17 Can gas generators also be used?

Yes, an upstream pressure of at least 5 bar has to be generated; the gas generated should have a purity of < 1 ppm CO_2 and < 1ppm hydrocarbons.

1.18 How much carrier gas is needed?

The gas consumption for the individual analyzers is between 8 and 15 l/h.

1.19 How long does a measurement take?

The average analysis time is 3 minutes per injection, dependent on the TOC concentration and the method selected.

1.20 Can carbon and nitrogen be determined simultaneously?

Carbon and nitrogen determination in liquid samples can be carried out simultaneously, i.e. from a single injection without exchange of the catalyst (only with thermocatalytic analyzers)

1.21 How long does the system need until it is ready for measurement?

The system is ready for measurement after approx. 15 min heat-up / equilibration time..

1.22 How long can a calibration be used?

Based on the VITA flow management system, the calibration remains stable for months. Even after catalyst replacement it is not mandatory to re-calibrate the system.

1.23 In which languages is the manual available?

The user manual is available in German, English, French and Spanish.

1.24 Is there electronic gas regulation and flow control?

With the aid of the VITA flow management system, continuous flow control is integrated in the system (not in multi N/C® 2100). Thus a reliable and stable NDIR detection is realized.

1.25 What is the VITA Flow Management System?

VITA Flow Management System (retention-time coupled integration for TOC analysis) is a technique patented by Analytik Jena, which enables an improved quality of analysis results. Essentially, gas flow fluctuations occurring during sample injections are taken into consideration in the evaluation of the FR-NDIR measurement signal.

1.26 Which advantages does VITA offer me?

- Improved precision of analysis results
- Improved detection limits
- Easy Cal – TOC calibration can be generated with various injection volumes from a single standard (especially interesting for ultra-pure water analyses)
- Long term stability of TOC calibration curves
- Significantly improved catalyst service life

1.27 Does the software indicate gas leakage?

Yes, gas leaks are indicated in TOC systems with VITA flow management system and therefore offer enormous labor-savings for the user. Furthermore, it is possible for the first time with these systems to produce verified TOC results fully automatically without gas leaks falsifying the analysis results.

2 Sample introduction

2.1 Is it possible to upgrade a multi N/C® analyzer by an autosampler later on without difficulties?

An analyzer can be upgraded by an autosampler at any time without problems.

2.2 How many positions are available on the autosampler?

Two different rack sizes are available for the APG 60 (multi NC® 2100/2100S) - 60 positions and 112 positions. There are 5 different rack sizes available for the APG 64 (multi NC 3100), 64 positions, 61 positions (POC rack), 35 positions (dilution rack), 116 positions and 18 positions. There are 3 racks available for the APG 49 (multi N/C® pharma HT/UV and multi N/C® UV HS): 49 positions, 18 positions and 64 positions (EPA rack)

Additionally, for the flow injection instruments (multi N/C® 3100, multi N/C® pharma HT/UV and multi N/C® UV HS), there are APG 10 and APG 21 available.

2.3 Which sample vessels are used?

no. of rack positions	10	18	21	35	49	60	64	61 (POC) 64 (EPA)	112	116
vessel size [ml]	50	100	50	50/12	100	8	30	40	2	12

2.4 Can the samples be stirred?

The APG 60 and APG 64 samplers are fitted with a stirrer function, where only the sample currently analyzed is homogenized.

There is no stirring function for APG 10 available.

APG 21 can optionally be equipped ex-factory with a stirring function. This stirring function can not be upgraded later on.

2.5 Which syringe sizes are available (only for multi N/C® 2100/ 2100S)?

A 500µl syringe is supplied as standard; a 100µl and 250µl syringe can also be ordered.

2.6 Which needles are available; how are they used to good effect? (only for multi N/C® 2100/ 2100S)

Two needle diameters are available:

1. Outer diameter (OD) 1 mm and inner diameter (ID) 0.7 mm; this needle is used for standard waste water applications and demonstrates a very good particle throughput. This needle is particularly recommended for systems with a septum-free port (multi N/C® 2100S). If it is used on a system with septum port (multi N/C® 2100), increased septum wear is possible.
2. Outer diameter (OD) 0.63 mm and inner diameter (ID) 0.35 mm; this needle is specially well suited for the lower concentration range < 5 mg/l TOC for nearly particle-free water samples (drinking water)

2.7 Can injection needles be replaced separately? (only for multi N/C® 2100/ 2100S)

Yes, of course, injection needles can be ordered and replaced separately.

2.8 Can a smaller volume be dosed with a 500µl syringe?

Yes, this is freely selectable in the software. However, for injection volumes of < 250 µl a smaller syringe is recommended. The syringe size simply needs to be set in the menu Configuration /Options / Instrument Components.

2.9 Can “thick” and “fine” needles be used for both autosamplers as well as manual syringes?

Yes, sampler syringes (500µl and 250µl) with “thick” (OD 1 mm) needles are supplied as standard, “fine” (OD 0.63 mm) can be adapted without difficulties.

Manual syringes and the 100µl autosampler syringe are supplied with “fine” needles as standard.

2.10 How are the syringes or sample suction needles rinsed?

Rinsing takes place prior to each new sample measurement; the sample to be measured is used for rinsing. A water rinse can also be used in-between.

2.11 Are carry-over effects to be expected?

As a result of the short sample paths, the appropriate needle rinses and annealing of the needle (with multi N/C® 2100/2100S), as well as intelligent valve flushing (with multi N/C® 3100), no carry-over effects are to be expected.

2.12 Which particle capabilities are ensured?

The smallest diameter of multi N/C® 3100 is the suction cannula with approx. 0.8 mm inner diameter. The removable needle on multi N/C® 2100/2100S has an inner diameter of 0.7 mm.

2.13 Can or must the sample vessel on the autosampler be covered?

A sample vial cover is generally not necessary for environmental samples (drinking water / waste water). In ultra-pure water sample analyses it is, however, recommended to cover the sample vessels with aluminum foil or to use EPA vials (septum closed sample vessels).

2.14 Can a sample series be set up using various methods?

Yes, depending on the requirements, each sample within a sequence can be measured with a different method.

2.15 Can samples be added to a sequence at any time? Is it possible to edit the “sample rack” during the run?

Yes, the multiWin software allows the user access to the sample sequence at any time and thus samples can be added or also be deleted during active measurement. Moreover, using the available quick position (last position on the rack) it is even possible to squeeze an urgent sample into the running sequence.

3 Sample digestion – high temperature combustion

3.1 Which catalyst material is used?

Pt material or CeO_2 is used as a catalyst, whereby the platinum catalyst is used as the standard material for the multi N/C® 2100/2100S and multi N/C® pharma HT, and cerium (IV) oxide is used as standard tube filling in multi N/C® 3100.

3.2 How is the combustion tube filled?

The combustion tube can be easily refilled by the operator within 15 minutes. This requires the catalyst, quartz wool, quartz cullets and a HT mat.

A pre-filled and certified reactor tube is available for the multi N/C® pharma HT.

3.3 Can the user replace the combustion tube himself?

There are just 3 essential steps required to replace the combustion tube and these are easy for the user to accomplish himself.

3.4 After how many injections is the catalyst consumed?

Depending on the sample matrix and volume, the catalyst is consumed after 500 to 10000 or even more injections (ultra-pure water).

3.5 At which temperature is the furnace operated for combustion?

The reactor can work at temperatures of up to 950°C. A temperature of 800°C is standard for the use of the Pt catalyst. When using the CeO_2 catalyst, a temperature of 850°C is recommended.

3.6 Does the furnace and the carrier gas supply switch off automatically?

Yes, the multiWin software offers the option, at the end of a measurement sequence, to set the system to a standby mode, where the furnace is cooled down to a preset furnace temperature (500°C recommended) and the carrier gas supply interrupted automatically. Alternatively, also only a carrier gas shut down after sequence end is available.

3.7 How long does it take for the furnace to reach its operation temperature?

It takes the furnace approx. 10 min. to attain a combustion temperature of 800°C or 850 °C.

3.8 What are the quartz cullets used for?

The quartz cullets as well as the HT mat are part of the protection layer in the combustion tube, which serves as salt absorber. They protect this way both, the catalyst as well as the combustion tube from salt load.

3.9 Does the combustion tube have to be cleaned?

No, cleaning is not absolutely necessary; when refilling the combustion tube, however, it should simply be rinsed with water and then be dried.

4 Sample digestion – wet chemical UV digestion with the high power UV reactor

4.1 How does wet chemical oxidation work?

The analyzer contains a specially developed UV reactor made of synthetic quartz glass with an integrated UV radiation source. The UV radiation source is directly surrounded by the reactor. The two different wavelengths of 185nm and 254nm are used. This assures a very high and efficient radiation density and thus a very high sample digestion power.

4.2 For which applications this kind of sample digestion principle can be used?

The wet chemical oxidation with persulfate and UV radiation at elevated temperatures is particularly suitable for the TOC analysis of water samples of low TOC concentrations and is also particularly suitable for the TOC determination in aggressive samples, e.g. acids, electrolytic bath solutions and strongly saline samples.

4.3 Can particle containing water samples be digested?

Most particles (depending on origin and nature) are by aid of wet chemical digestion not completely oxidized.

4.4 Is the persulfate solution necessary for the oxidation?

Not generally. For samples of less than 1 mg/l TOC concentration it is recommended to work without persulfate. The system blank can be kept very low that way and the sensitivity of the system increases.

For higher concentrations or with samples of high matrix load, the use of persulfate is necessary in order to guarantee a complete sample digestion.

4.5 Which advantages are offered by the high power long life UV reactor?

- Utilization of two wavelengths (185 and 254nm, the hard UV radiation at 185 nm is especially energy rich and powerful)
- Direct contact of sample and UV radiation source
- Reactor is designed without sealing or welding line
- Complete sample digestion with low consumable costs

4.6 What is the expected life time of the high power long life UV reactor?

Usually the reactor can be operated for 1 to 2 years.

5 Auto protection

5.1 What is meant by auto protection?

Auto protection is a combination of measurement gas drying, measurement gas clean-up and the automatic control of this (by means of temperature and pressure sensors) with the aim to protect the valuable system components.

5.2 How is the measurement gas dried?

Drying of the measurement gas is done in a 2 step process. First the measurement gas is dehydrated in a condensation coil and then fine drying takes place with the aid of a Peltier element. The Peltier element is permanently checked for good operation (temperature control). The two additional filters (aerosol and water trap) following up the fine drying are pressure controlled and the system is automatically shut down in case of loaded filters. Drying of the measurement gas is therefore particularly effective and requires little maintenance.

5.3 How maintenance intensive is the Peltier element?

The Peltier element for measurement gas drying requires no maintenance.

5.4 Does the condensation - IC vessel have to be cleaned?

No, cleaning of the condensation vessel is generally not required due to the consistent glass design. Exception: only samples with high particle content, which are measured in the difference mode, require occasional cleaning of the IC vessel.

5.5 Do the aerosol and water traps often have to be replaced?

No. Preventive replacement once a year is usually sufficient. The traps are easy and inexpensive to be replaced. They serve to effectively protect the detector against premature aging. An integrated pressure control ensures a system shut down in case of over loaded aerosol and water traps.

6 Detection

6.1 What is a FR-NDIR?

For this detector, FR stands for focus radiation, i.e. the infrared radiation inside the detector is focused by aid of an integrated optics onto the micro detector. This guarantees a very high radiation yield and hence measurement sensitivity. The detector is more over also absolutely independent from the wall reflection of IR radiation, which enables the use of corrosion-free glass as gas cuvette material. Practically spoken is this detector much more robust and long-term stable than any common NDIR detector (based on wall reflection technology).

The FR-NDIR is a wide range detector without channel separation.

6.2 How works nitrogen detection?

There are two detectors available to determine nitrogen content: the chemodetector (ChD) and the chemiluminescence detector (CLD).

6.3 Is the functionality of the detectors checked?

Yes, continuous monitoring of the detectors takes place with the Self Check System (SCS).

7 Solid modules

7.1 Which essential differences exist between the double furnace module and an external solid furnace (HT 1300)?

The double furnace allows TOC liquid and solid analysis in one system without an additional solid module. It works on the principle of catalytic high temperature combustion at up to 950°C. Conversion of the analyzer is easy and for most of the solid analyses the double furnace module works well.

For special applications, the external HT module offers a higher combustion temperature of up to 1300 °C, and enables the use of larger sample boats, allowing a sample weight of up to 3 g. If a HT module is used, no conversion of the basic device and no catalyst is necessary.

7.2 Which combustion tubes are used?

In the case of the double furnace module, a quartz glass tube filled with CeO_2 is used.

Due to the higher temperatures, in the HT 1300 an especially robust ceramic combustion tube is used.

7.3 Which types of sample trays are used?

Quartz glass boats are used for the double furnace module and porcelain boats for the HT 1300.

7.4 Can the solid method be automated?

No, the TOC solid method can not be automated with any analyzer of the multi N/C® series.

As an automated solid TOC analyzer multi EA® 4000 in combination with the TIC automatic module and the solid sampler FPG 48 is available.

7.5 Is it possible to run nitrogen analysis in solid samples?

No.

7.6 Is an additional gas supply required?

No additional gas supply is required for the double furnace module; an additional carrier gas connection (only oxygen, purity 2.5 (99.5%) sufficient) is required for HT 1300.

8 TN-option

8.1 How works the chemodetector (ChD)?

The chemodetector is based on an electrochemical measurement principle. An appropriate electrode system in combination with a selective gas-permeable membrane and a solid-state electrolyte enables specific detection of NO.

8.2 How maintenance-intensive is the chemodetector?

The chemodetector requires absolutely no maintenance.

8.3 How works the chemiluminescence detector (CLD)?

The NO formed by combustion of the sample reacts with the ozone, generated in the CLD, to produce enriched NO_2*, which returns to its natural energy state accompanied by the emission of a specific amount of energy (luminescence radiation). This signal is detected and evaluated. Ozone generation and the destruction of the excess ozone take place directly inside the detector module.

For ozone generation the CLD detector needs additional carrier gas (recommended: synthetic air, approx. 50 ml/min).

9 multiWin® Software

9.1 Is the software FDA compliant?

Yes, the multiWin software for the multi N/C® series is fully FDA 21 CFR part 11 compliant.

9.2 Is a LIMS link possible?

Yes, multiWin allows the import and export of LIMS files.

9.3 Can different user levels be created?

Yes, a user management is integrated to multiWin software.

It is possible to assign defined user level and access rights for all procedures and functions of the multiWin software to different users.

9.4 Are electronic signatures enabled?

Yes, electronic signatures can be added as “provided”, “examined” and “authorized” to analysis reports as well as to calibration files.

9.5 Is an audit trail integrated in the software?

Yes, an audit trail is integrated to multiWin software.

9.6 Can files be exported?

Yes, calibration and analysis data can be exported in Excel and LIMS readable formats. Methods, calibration and analysis data can be exported also in multiWin readable formats.

9.7 Which operating system is required for the software?

All operating systems like MS Windows XP and higher are suitable for the multiWin® software. The software operation is tested under MS Windows 7 (32- and 64-bit version)

9.8 Is the software network-compatible?

Yes, the software is network-compatible.

10 Self Check System

10.1 What is the Self Check System?

The automatic monitoring of important system components – this avoids typical user errors and erroneous analysis results. The user-friendliness of the analyzer increases significantly.

10.2 Which components are monitored by the Self Check System?

The SCS includes electronic gas regulation, electronic CLD monitoring, electronic FR-NDIR monitoring, electronic temperature monitoring of the furnace and Peltier element, automatic gas shutdown, automatic monitoring of the maintenance intervals, electronic leakage control, as well as TIC controls in NPOC methods.